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Hospital-based versus home-based proprioceptive and strengthening exercise programs in knee osteoarthritis

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Objectives: This study aimed to establish the effects of hospital- and home-based proprioceptive and strengthening exercise programs on proprioception, pain, and functional status in patients with knee osteoarthritis (OA).

Methods: Sixty patients with bilateral knee OA were randomly allocated into either a home-based or hospital-based exercise program. Hospital-based exercise group (n=30, mean age 50.23±9.07 years) received functional training program with proprioceptive ability, ice, and home exercises. Home-based exercise group (n=30, mean age 54.4±7.9 years) had a program of ice and home exercises. Treatment programs was conducted 5 days per week for 6 weeks (30 sessions). Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Monitorized Functional Squat System-Proprioceptive Test (MFSS), timed performance test (TUG), and visual analogue scale (VAS) for the intensity of pain were used to quantify the variables.

Results: Both groups demonstrated significant improvement when pre- and post-treatment results were compared for pain intensity, WOMAC, and TUG test scores ($p<0.05$). No statistically significant improvement was found in proprioception of the home-based group ($p>0.05$). Hospital-based group demonstrated significantly greater improvement in MFSS, TUG test, and VAS in activity when compared with the home-based group ($p<0.05$).

Conclusion: Both hospital- and home-based exercise programs decreased joint symptoms and improved function in patients with knee OA.

Key words: Exercise; knee; osteoarthritis; pain; proprioception, strength.

Knee osteoarthritis (OA) is a commonly observed problem, especially in the elderly. It is a health problem characterized not only by pain, but also by muscle weakness and physical dysfunction.[1]

Treatment of knee OA is oriented towards reducing pain and improving physical function. Treatment approaches today include drug therapy, hyaluronic acid injection, glucosamine and chondroitin sulphate use, exercises, physiotherapy, techniques for restoring knee alignment (knee orthosis, neoprene knee pads, insocks, banding techniques), and diet applications for weight loss.[1-3]

In recent years, there has been an increasing interest in studies on possible exercise treatments and the most appropriate exercise programs in OA.[4] Some scientific institutions (EULAR, ACR) have published

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clinical guidelines for the treatment of lower extremity OA (Table 1);[4-7] however, these guidelines have not been proven and adopted by the healthcare profession.

Hospital-based strengthening exercise programs are used for increasing muscle strength, and facilitation techniques are used for improving the proprioceptive function.[8,9] Proprioception is an important sensory system that enables patients to perceive joint position and movement as well as strength.[8] Inadequate proprioception also causes muscular weakness in individuals.[8,9] Proprioception in knee joint consists of the feedbacks received from receptors in intra-articular structures such as ligaments and capsules, and receptors in extra-articular structures such as tendons and muscles.[10] Proprioception plays a highly important role in achieving knee stabilization in a static position and during walking.[11]

It has been reported in some studies that strengthening and aerobic exercise programs are effective in improving symptoms induced by OA;[1,12] however, there is still no accepted approach in the literature on the type, intensity, and frequency of exercises.[13] In addition, only a few studies have evaluated the long-term effects of strengthening exercises on muscle strength in patients with knee OA.

The objective of this study was to compare the effects of home-based and hospital-based exercise programs on pain, proprioception, and functional condition in patients with knee OA.

Patients and methods

Included in the study were patients who had been diagnosed with knee OA, and had been transferred to our department by the same orthopedist. Inclusion criteria were age at least 50 years, diagnosis of bilateral knee OA, not having received treatment for knee OA in the last 6 months, absence of any cardiovascular, neurological, orthopedic, or metabolic disease that could prevent exercise, and no history of knee surgery.

The study included 60 patients who met inclusion criteria. Patients who gave informed consent were divided into two groups by a randomization method. The hospital-based treatment program (n=30; mean age, 51.2±6.4 years) consisted of proprioceptive exercise training by "Monitored Rehabilitation Systems – Functional Squat System" (MRS-E0203 – MFSS) and a home program including application of a cold compress, and strengthening exercises; whereas the program of home exercise group (n=30; mean age, 53.9±9.1 years) consisted of application of a cold compress, and proprioception and strengthening exercises. All patients completed the treatment program of 30 sessions, which were conducted

Table 1
Recommendations of important scientific institutions for osteoarthritis treatment

	Recommendations
American College of Rheumatology (ACR)[4-6]	Education
	Social support with phone
	Weigth loss
	Aerobic exercise programs
	Proper shoe
	Brace
	Ergotherapy
The European League Against Rheumatism (EULAR)[7]	Quadriceps exercises
	Canadian or crutch use
	Shoes with orthotic supports
	Phone integration

5 days per week for a total of 6 weeks. The following evaluations were performed:

Evaluation of pain

Visual analogue scale (VAS), which is one of the most frequently used methods in literature, was used in the evaluation.[8] The patients were asked for how long they had been experiencing knee pain. Knee pain was evaluated at rest, while climbing or descending stairs, and at night. Numerical criteria were used in the evaluation. A 10-cm horizontal line was labeled from 0 to 10, "0" indicating "no pain" and "10" indicating "maximum, unbearable pain". Patients were asked to mark the severity score of their pain on the line.[8]

Evaluation of proprioception

MFSS is a system that enables evaluation of the lower extremity throughout the concentric and eccentric phases during functional squat movement (Fig. 1a). The relative position of the patient is displayed on the computer screen. During the test, patients are asked to follow the red "+" sign and blue line on the screen by eccentric and concentric knee movements (Fig. 1b). After the completion of the test, the difference between the deviations recorded with and without visual input was evaluated throughout the concentric and eccentric phases of movement. MFSS is reported in the literature as a valid and reliable method used in the evaluation of proprioception.[14] After the evaluation, patients were given an exercise program to improve proprioception.

Body composition analysis

Body weight, body fat percentage, and body mass index (BMI) were evaluated by the TANITA Body Composition Analyzer (TBF-300M, Japan). Patients were asked to wear shorts and T-shirts while participating in the evaluation. After the age, height, and gender of each patient were entered into the device, they were asked to step on the sensors on the device in bare feet, and to step off the device after a few seconds of measurement. Measurement results were given by the device as a print-out.[15]

Functional evaluations

Time-up and Go Test (TUG): Patients were asked to wait in sitting position, to stand up from the chair when instructed, and to walk a pre-specified distance of 3 m as fast as they could, and then to go back and sit down again. The time from standing up from the chair to sitting down again was recorded by a chronometer.

WOMAC (The Western Ontario and McMaster Universities Osteoarthritis Index) LK3.1 Questionnaire: The questionnaire consisted of 3 sections which included 24 questions on pain (5 questions), malfunction (2 questions), and physical function, thus addressing difficulties experienced in performing certain activities in daily life. The 5-point Likert form of the questionnaire was used in our study. The total score in the Likert form is 96 (0: best, 96: worst). The most recent 48 hours were assessed in the questionnaire.[16]

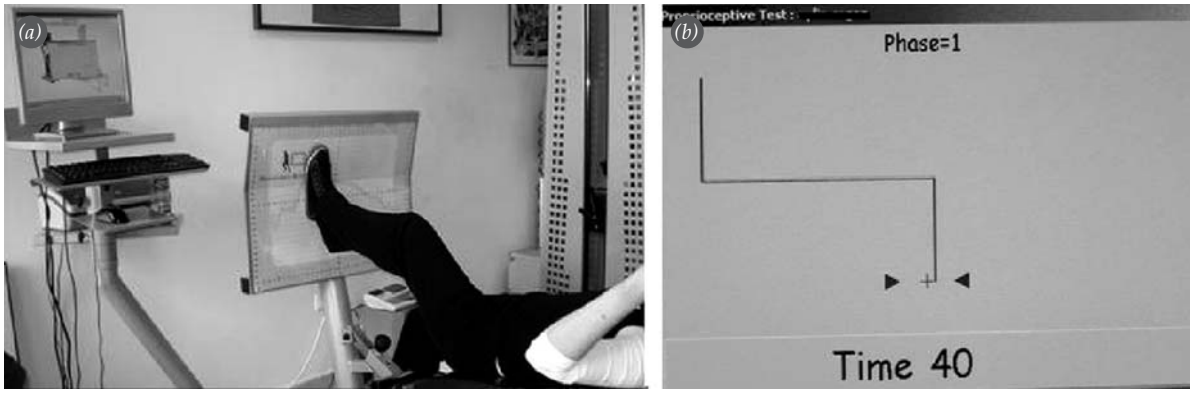

Fig. 1. Evaluation of proprioception in Monitorized Rehabilitation Systems-Functional Squat System. **(a)** Position of the patient, and **(b)** computer screen during proprioception test.

The program assigned to patients in MFSS in the hospital

The program was applied to patients by using MFSS, which includes special programs for improving the co-contraction of quadriceps and hamstring muscle groups, and joint position sensation in a closed kinetic chain (CKC) position (Fig. 1).

Patients were asked to perform proprioception and strengthening exercises, which were assigned as a home program, 3 times per day, for 10 repetitions.

Statistical analysis

Data obtained from the patients were analyzed by using SPSS 13.0 statistics packet program operated under the Windows operating system. In both treatment groups, data obtained from patients before and after the treatment were assessed by using the Paired Sample t-test. The statistical analysis method of Independent Sample t-test was used in the analysis of differences between the two groups. Statistical significance level was determined as $p<0.05$.

Results

When the physical characteristics of both groups were compared, no statistically significant difference was found between the two groups for age, height, body weight, and body mass index values of patients ($p>0.05$, Table 2). The BMI of participants in the hospital-based treatment group was 27.45±4.33 kg/m^2, and was 28.80±5.14 kg/m^2 in the home-based group, both above the normal range.

In the post-treatment measurements of patients in both groups, a statistically significant reduction was observed in pain values evaluated during rest or movement, and at night ($p<0.05$, Table 3). When the difference between both groups was evaluated, a statistically significant difference was found between the groups in terms of the pain values during activity of the right and left knee ($p<0.05$), while no difference was observed between the groups in terms of the pain values experienced during rest or at night ($p>0.05$, Table 4).

In proprioception measurements, the results of the hospital-based treatment group showed a statistically significant increase after the treatment ($p<0.05$, Table 3), while the increase in the home exercise group was not found to be statistically significant ($p>0.05$, Table 3). The change in proprioception values of the participants in the hospital-based treatment group was observed to be statistically more significant compared with values of the participants in the home exercise group ($p<0.05$, Table 4).

When WOMAC questionnaire and TUG test results were compared, a significant change was recorded in post-treatment values of both groups in comparison with pre-treatment values ($p<0.05$, Table 3), whereas only TUG test results achieved a statistically significant difference in the evaluation between the groups ($p<0.05$, Table 4).

Discussion

This study has shown that both home- and hospital-based proprioception and strengthening exercise programs are effective in decreasing pain, and improving proprioception and the functional status of patients with knee OA.

OA is commonly observed in the clinic, and it is one of the most frequently encountered problems of

Table 2

Physical characteristics of the patients (mean±SD)

	Hospital-based training (n=30)	Home-based training (n=30)	T	p value*
Age (year)	50.23± 9.07	54.4±7.99	-1.88	0.064
Height (cm)	159.80±5.31	160.66±4.95	-0.60	0.54
Body weight (kg)	69.59±11.19	74.03±12.61	-1.44	0.15
Body mass index (kg/m^2)	27.45±4.33	28.8±5.14	-0.50	0.61

*Independent sample t test.

Table 3
Pre- and post-treatment analysis (mean±SD)

	Hospital-based training (n=30)				Home-based training (n=30)			
	Pre-treatment	Post-treatment	T	p value*	Pre-treatment	Post-treatment	T	p value*
Body weight (kg)	69.59±11.19	69.42±11.16	1.36	0.18	74.03±12.61	73.69±12.45	1.54	0.13
BMI (kg/m^2)	27.45±4.33	27.34±4.41	1.18	0.24	28.80±5.14	28.75±5.05	1.54	0.45
Fat ratio (%)	40.54±7.32	39.35±7.81	-2.07	0.04	41.22±9.91	40.74±9.30	0.75	0.22
Left knee VAS rest	1.93±2.42	0.73±1.70	4.20	<0.01	2.20±2.05	0.63±1.29	1.25	<0.01
Activity	5.60±2.31	1.46±2.04	10.63	<0.01	5.96±2.14	2.80±2.02	5.80	<0.01
Night	2.70±2.98	0.76±1.92	4.53	<0.01	3.33±3.48	1.40±2.26	12.24	<0.01
Right knee VAS rest	1.86±2.04	0.30±0.83	4.63	<0.01	1.86±2.04	0.56±1.27	4.78	<0.01
Activity	6.03±2.22	1.66±1.58	11.52	<0.01	5.73±2.50	2.40±1.58	4.22	<0.01
Night	2.50±2.86	0.53±1.30	4.54	<0.01	2.76±3.09	0.33±.75	11.69	<0.01
Proprioception	11.96±2.10	14.26±2.88	-4.91	<0.01	12.33±2.59	13.03±2.97	-1.32	0.19
WOMAC	10.22±4.51	5.45±3.76	7.93	<0.01	9.48±3.61	5.69±2.84	8.89	<0.01
TUG (sec)	6.25±1.33	5.19±1.05	10.17	<0.01	6.85±1.84	5.39±1.46	8.83	<0.01

*Independent sample t test, BMI: Body mass index, VAS: Visual analogue scale, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, TUG: Time-up and go test.

knee pathology. There are various rehabilitative approaches to treat OA. It is important to improve physical performance while decreasing pain and improving proprioception in rehabilitation. Achieving accurate proprioceptive sensation, and providing dynamic stabilization during daily knee activities has a significant place in treatment programs. Thus, exercise training is often emphasized in literature concerning the rehabilitation of patients with OA.

Our study revealed no difference in the age, height, body weight, and body mass index of the participants. The study was conducted with a homogenous group.

Balcı et al.[17] reported that exercise training performed by MFSS resulted in a decrease in knee pain in patients with patellofemoral pain syndrome, and Fehr et al.[18] showed in their studies that leg presses and slight squat exercises were effective in reducing pain.

It is important that the exercises given to patients in an early period to prepare them for activities of daily living are designed to address the functional aspects of those activities. Stabilization of knee, hip, and ankle joints is achieved by eccentric control of the gluteus maximus, gastrocnemius, and quadriceps muscles while descending stairs or a slope, and during squatting activity. There should be full motor control and coordination during these activities. Several activities performed in daily life consist of CKC movements. During these CKC activities, muscles move more in an eccentric way.[14]

Lin et al.[8] divided 89 patients with knee OA, into three groups: one control group and two exercise groups, and applied different treatments for 8 weeks. There were 62 women and 27 men, all of whom were over 50 years of age. First group (30 patients) was given CKC exercises, and second group (29 patients) was given computerized proprioceptive exercise training in a sitting position with knees in flexion. Post-treatment improvement was detected in the proprioceptive values of patients; however, the authors did not report any difference between the treatment groups.

The aim of the exercise training given in our study was to achieve reduction in pain as well as improvement in proprioception. Strengthening exercises and proprioceptive training were given togeth-

Table 4
Comparison of the groups for differences between pre- and post-treatment values (mean±SD)

	Hospital-based training (n=30)	Home-based training (n=30)	T	p value*
Body weight (kg)	-0.17±0.68	-0.34±1.2	0.67	0.50
BMI (kg/m^2)	-0.11±0.52	-0.05±0.38	-0.50	0.61
Fat ratio (%)	-1.47±3.90	0.48±2.11	-2.42	0.02
Left knee VAS Rest	1.20±1.56	-1.56±1.47	0.93	0.35
Activity	-4.13±2.12	-3.16±1.41	-2.07	0.04
Night	-1.93±2.33	-1.93±2.21	0.00	1.0
Right knee VAS Rest	-1.56±1.85	-1.30±1.68	-0.58	0.56
Activity	-4.36±2.07	-3.33±1.56	-2.17	0.03
Night	-1.96±2.37	-2.43±2.78	0.69	0.48
Proprioception	2.30±2.56	0.70±2.90	2.26	0.02
WOMAC	-4.76±3.29	-3.78±2.32	-1.33	0.18
TUG (sec)	-1.05±0.56	-1.46±.90	2.08	0.04

*Independent sample t test, BMI: Body mass index, VAS: Visual analogue scale, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index, TUG: Time-up and go test.

er in the treatment in order to improve proprioceptive sense during functional activities. Improvement was observed in both groups post treatment. The improvement rate in pain values and proprioception measurements during activities was observed to be greater in the group of patients who were admitted to the functional treatment program in the hospital than it was in the group of patients who followed the home program. We believe that the reason that better results were achieved in the hospital-based group was the fact that the patients included in hospital-based treatment program completed the exercise program under supervision, and received proprioceptive training using the MFSS.

It is important to evaluate the decreased performance during functional movements in OA in order to determine the effect of treatment on daily life activities. Standing up from a sitting position is one of the activities, which causes an increase in the symptoms of patients with OA. The TUG test is described in the literature, mostly in evaluating the functional levels of patients with OA. The activities of sitting, standing up quickly, and walking fast use a combination of concentric and eccentric muscle contractions.[19] The TUG test used in our study is an important test in terms of the assessment of decreased walking performance due to pain, muscle weakness, and decreased muscular endurance and proprioception. Improvement in patient performance during functional activities was achieved in our study. We are of the opinion that TUG test post-treatment results were better in the hospital-based treatment group, because the decrease in pain, especially during activities, resulted in an increase in participation in functional activities, and led to a decrease in test duration as the result of improvement in walking performance.

WOMAC questionnaire is commonly used in evaluating physical function, and it is often used in knee and hip osteoarthritis.

Tüzün et al.[16] investigated the validity and reliability of the Turkish version of the WOMAC questionnaire in 72 patients over 40 years of age with knee OA, and concluded that the validity and reliability of the Turkish version were high. No relationship was found between the WOMAC scores of patients and their education level, age, pain severity and duration, or physical function. At the end of this

study, they reported that WOMAC 3.1 could be used in the evaluation of patients with OA.

Evcik et al.[20] evaluated the functional capacity and pain by using WOMAC and VAS, respectively, in 35 patients with knee OA, who were 42-77 years of age (27 women and 8 men). A moderate relationship was found between the WOMAC scores and pain levels.

Dıraçoğlu et al.[21] reported that kinesthesia and balance exercises assigned to OA patients in addition to strengthening program resulted in an increase in their WOMAC scores and functional capacity.

In our study, a decrease was recorded in patients' WOMAC scores and pain levels assessed by VAS at the end of both treatments. No difference was found between the groups in terms of WOMAC scores. Improvement was significant in both groups.

Thus, proprioceptive training is an important subject to be considered in the treatment of patients with knee OA. Regular application of a well-planned treatment program consisting of home- and hospital-based proprioceptive and strengthening exercises has a significant effect on reducing pain and improving function and proprioception in patients with knee OA. Daily patient follow-up in clinical programs and the feedback given to patients together increase the effect of this treatment program.

On the other hand, in home-based programs it is not possible to control whether the program is regularly applied by the patients; however, we believe that exercise programs may be applied by patients on a more regular basis if patients are informed about knee OA, the significance of exercise programs and the surgical interventions they may go through in the future unless they regularly perform these exercises. After all, the success of treatment in OA depends largely on the patient. Supporting hospital-based programs with home exercise programs will provide a temporary decrease in symptoms and complaints. We believe that possible future surgical indications may be reduced if patients learn a well-planned exercise program consisting of proprioceptive and strengthening exercises, and manage to turn this program into a way of life. Thus, long-term controlled studies are needed to determine whether treatment success is maintained. Patients who participated in this study should have long-term follow-up.

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